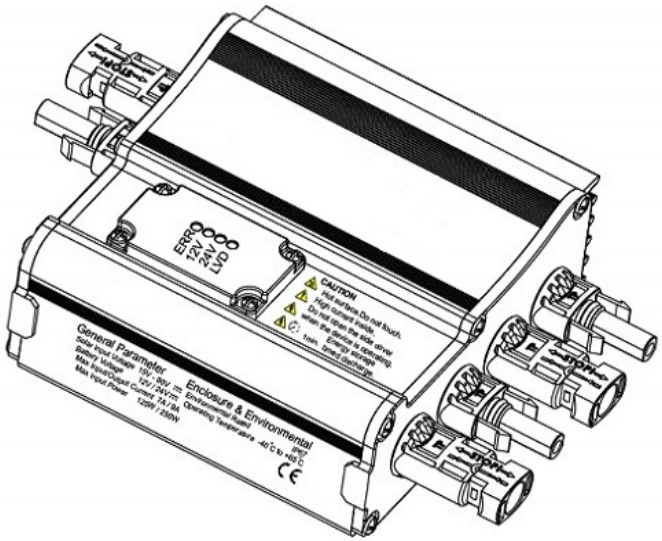
# User Manual

**PCM-924, 9A / 80Voc Input MPPT Controller for Thin-Film PVs**

# IP67 Weather Resistant

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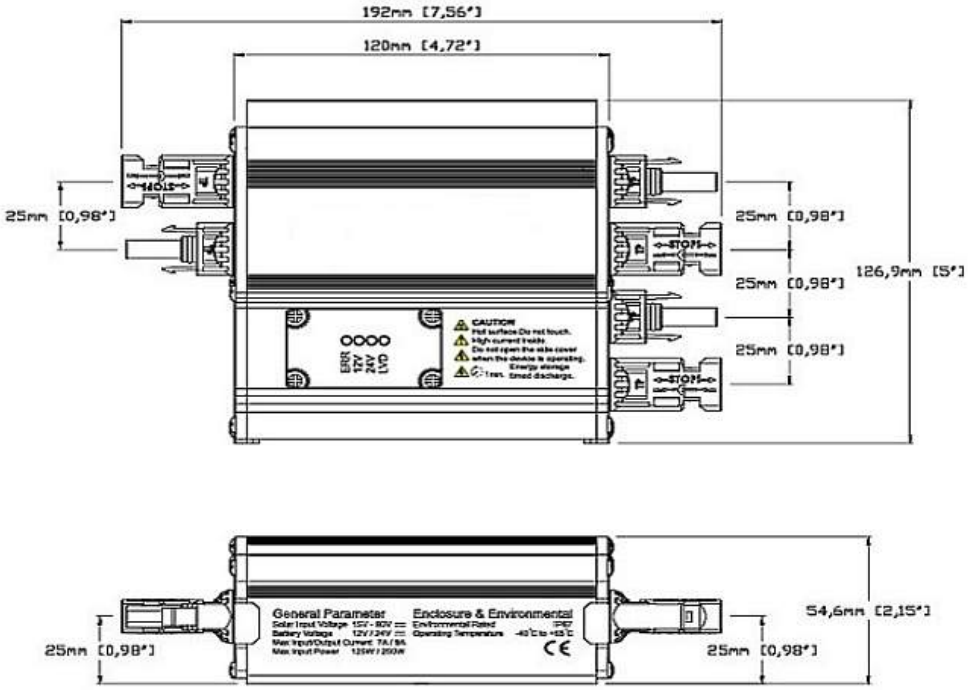
Ver. 1.0

# Physical Dimension




# Specification

| Reference | Unit | PCM-924 |
|---|---|---|
| Max. input DC. power | W | 250(24V) / 125(12V) |
| Max. input solar panel DC. voltage* | V | 80 |
| Max. input solar panel DC. current | A | 7 |
| Rated battery voltage | V | 12 / 24 (Automatic) |
| Max. charge/loading current | A | 9/7 |
| Degree of protection | | IP67 |

***The voltage of solar panel array can not be higher than the max. input voltage of controller.**

***The solar panel components voltage of system could not be lower than voltage of battery, and not be higher than max. input power.**

***The output of Load voltage depends on the output of battery voltage.**

-As reference of solar panel components, to calculate open-circuit voltage (highest values) under the lowest temperature circumstance of installation. The values could not over the max. input voltage – 80Vdc.

-When sunlight irradiation solar panel components, will be produced voltage and current in the input line.

-The capacity of the battery pack is unlimited, it will only affect the charging rate.

-Follow the following guide to use the product, otherwise they may damage equipment

# Category

# 1. Important Safety Instruction

Save These Instructions
This manual contains important safety, installation and operating instructions for the MPPT solar controller.

The following symbols are used throughout this manual to indicate potentially dangerous conditions or mark important safety instructions.

**WARNING: Indicates a potentially dangerous condition. Use extreme caution when performing this task.**

**CAUTION: Indicates a critical procedure for safe and proper operation of the controller.**

**NOTE: Indicates a procedure or function that is important for the safe and proper operation of the controller.**

## 1.1 General Safety Information

- Read all of the instructions and cautions in the manual before beginning installation.
- There are no user serviceable parts inside the MPPT. Do not disassemble or attempt to repair the controller.
- Disconnect all sources of power to the controller before installing or adjusting the MPPT.
- There are no fuses or disconnects inside the MPPT.
- Prohibition of water into the controller.
- Confirm that power connections are tightened to avoid excessive heating from a loose connection.

# 2. General Information

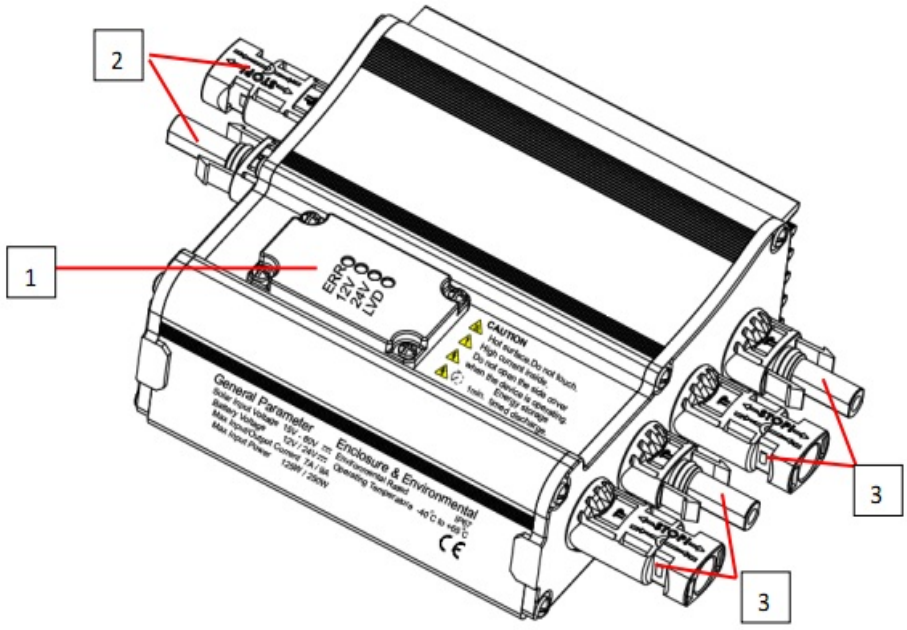
## 2.1 Summary

Thanks for selecting the MPPT charge controller. This MPPT controller is an advanced maximum power point tracking solar battery charger and loading device for stand-alone PV systems. The controller features a smart tracking algorithm that maximizes the energy from the solar module and also provides load control to prevent over-discharge of the battery.

**The process of MPPT battery charger has been optimized for long battery life and improved system performance.**

Although the MPPT is very simple to operate and use, please take the time to read this operator's manual and become familiar with the controller. It will help you make full use of many advantages which MPPT can provide for your PV system.

Features of the MPPT controller is shown as below.




**1 - Status LED Indicator**

Four LED Indicator show charging status and battery input and low voltage fault condition.

**2 - Solar Input Connector**

The connecting terminal of systems solar panel components input.

**3 - Battery Input & Loading Output Connector**

Systems battery components input and loading out terminals

# 3. Installation Instructions

## 3.1 Installation Note

Read through the entire installation section first before beginning installation.

- Be very careful when working with batteries. Wear eye protection. Have fresh water available to wash and clean any contact with battery acid.
- Use insulated tools and avoid placing metal objects near the batteries.
- Explosive battery gasses may be present during charging. Be certain there is

sufficient ventilation to release the gasses.

- Do not install in locations where water can enter the controller.
- Loose power connections and/or corroded wires may result in resistive connections that melt wire insulation, burn surrounding materials, or even cause fire. Ensure tight connections and use cable clamps to secure cables and prevent them from swaying in mobile applications.
- Only charge lead-acid batteries.
- The controllers battery connection may be wired to one battery or a bank of batteries. The following instructions refer to a singular battery, but it is implied that the battery connection can be made to either one battery or a group of batteries in a battery bank.

## 3.2 Mounting

Note: When mounting the MPPT controller, ensure free air flow through the controller heat sink fins. There should be at least 150mm of clearance above and below the controller to allow for cooling. If mounted in an enclosure, ventilation is highly recommended.

Warning: Risk of explosion! Never install the controller in a sealed enclosure with vented (flooded) batteries! Do not install in a confined area where battery gasses can accumulate.

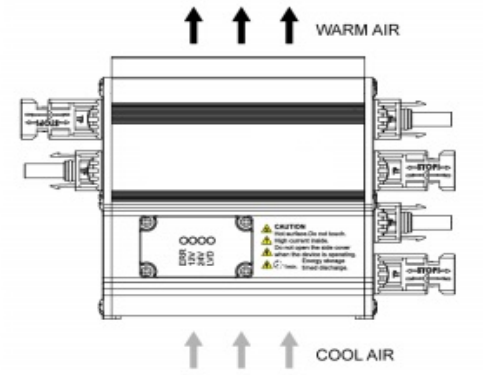
Step 1: Choose Mounting Location

Locate the controller on a vertical surface protected from direct sun, high temperatures, and water.

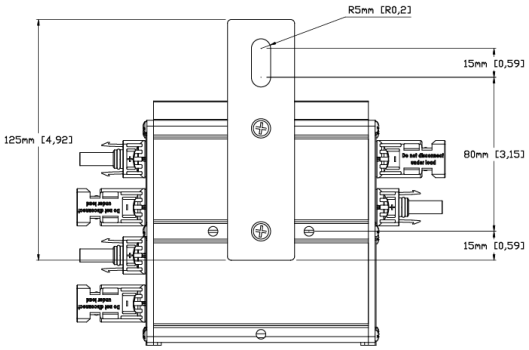
Step 2: Check for Clearance

Place the controller in the location where it will be mounted. Verify that there is sufficient room to run wires and that there is ample room above and below the controller for air flow.

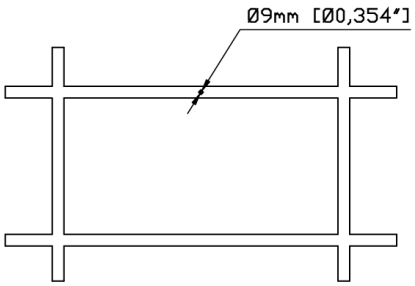
Figure 2: Mounting and cooling.




Step 3: Fasten the Flat
Fasten flats on the three back holes of controller.



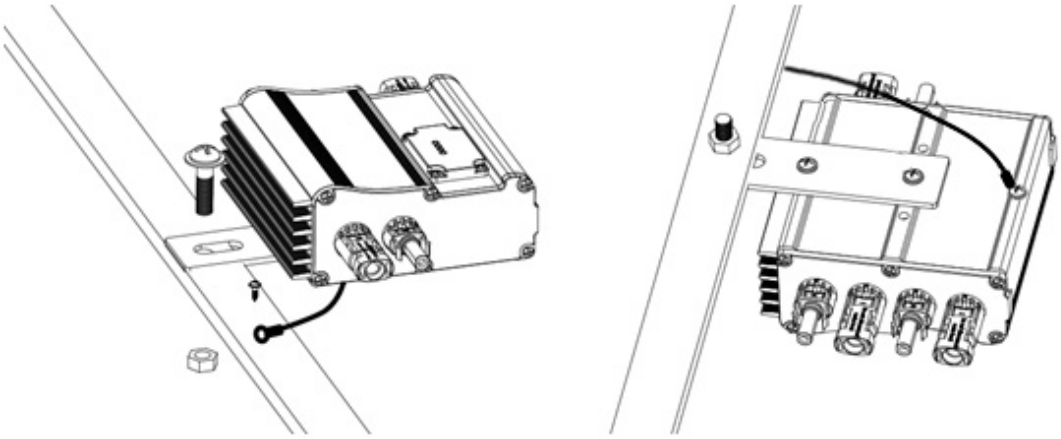

Step 4: Drill Holes
Drill dimension 9mm holes (spacing 220mm )in the mounting location.




Step 5: Secure Controller
Then put the the back-end bracket mounting holes of the controller on the solar panel bracket, aligning the hole drilled in step 4, using screws and nuts fixed controller, and indeed the case ground wire connected.

## 3.3 Wiring

Note: A recommended connection order has been provided for maximum safety during installation. The controller will not be damaged regardless of the sequence of connections.



Note: The MPPT controller is a negative grounding controller.

Caution: the total current draw of all system loads connected to the controller's load terminals cannot exceed the 7A load current rating.

Caution: For mobile applications, be sure to secure all wiring. Use cable clamps to prevent cables from swaying when the vehicle is in motion. Unsecured cables create loose and resistive connections which may lead to excessive heating and/or fire.

Step 1: Load Wiring

The controller's load output connection will provide battery voltage to system loads such as lights, pumps, motors, and electronic devices. The voltage of the loads should be depended on the voltage of the battery.

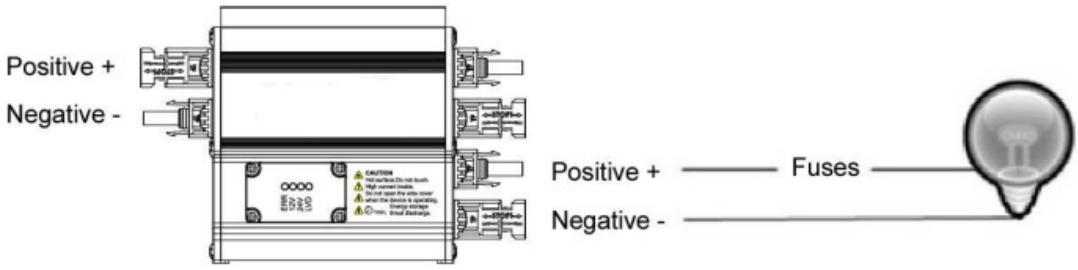



Figure 3 Load wiring

As shown in figure 3, connect load positive (+) and negative (-) load wires to the system load(s) or load distribution panel.
An in-line fuse holder should be wired in series in the load positive (+) wire as shown. DO NOT INSERT A FUSE AT THIS TIME.
If wiring the load connection to a load distribution panel, each load circuit should be fused separately. The total load draw should not exceed the 7A load rating.

Step 2: Battery Wiring

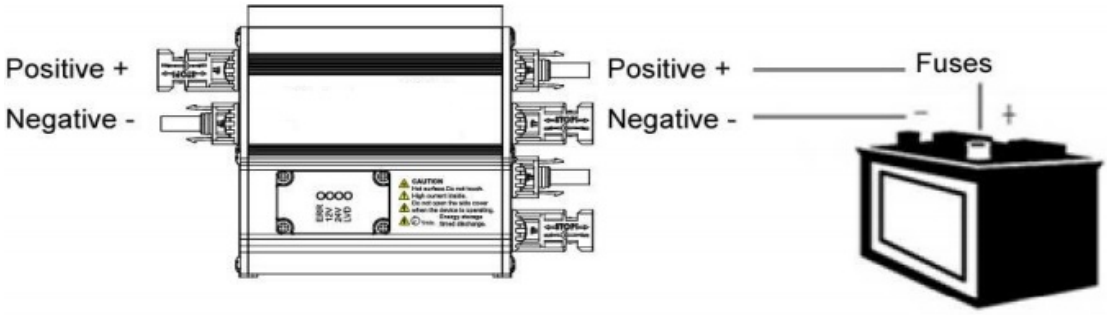



Figure 4. Battery wiring

Before connecting the battery, measure the battery voltage. It must be over 11 volts to switch on the controller. For 24 volt systems, the battery voltage must be greater than 22 volts. The battery detection is automatic and the check is only performed at start-up.

Wire an in-line fuse holder no more than 150mm from the battery positive terminal.

DO NOT INSERT A FUSE AT THIS TIME.

Step3: Solar Panel Array Connecting

Caution: Danger!! Electrical Shock!! High voltage will occur from the solar panel, please covering the solar panel before wiring.

This MPPT controller is suitable for 12V and 24V off-grid solar systems, also suitable for the connecting array which the Voc lower than 80V. The working voltage should be located between the battery voltage and maximum out-put voltage of solar systems.

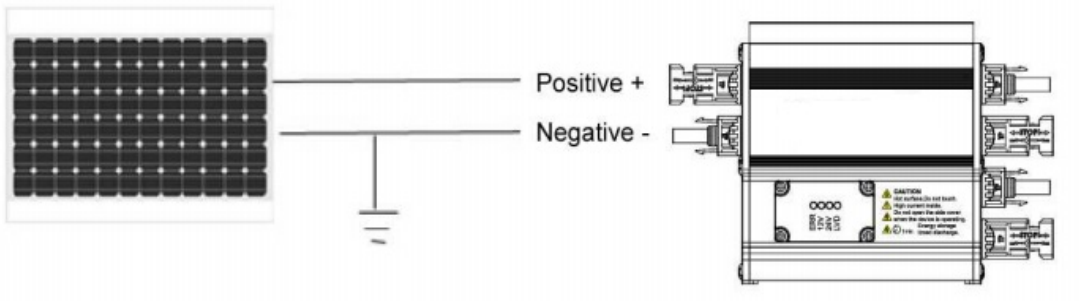



Fig. 5 Solar penal array connecting method.

Step 4: Recheck all connecting points, and confirm all poles at right connecting positions, check all connecting terminals are fixed.

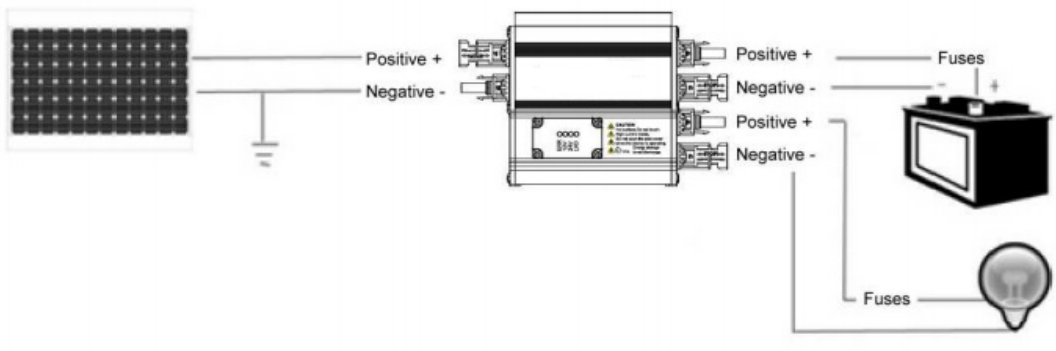



Fig 6. Reconfirm all connecting points.

Step 5: Fuse inserting
Insert a 15A DC fuse as follow steps:

1. Loads circuit.
2. Battery circuit.

Step 6:Electrify Confirmation
Please confirm the following electrify steps, when the battery electrify the power to controller, the LED lights on unit will flash in order, and detect the voltage of battery, automatically. The charge LED light will flash in charging.

Please check chapter 5 Trouble Shooting, if the unit did not work or the LED lighting shows the wrong identifications.

# 4. Operation

## 4.1 Status LED Indicator

Status indicator

The status LED indicator charging status and any existing solar input error conditions. The status LED will off whenever an error conditions exists. The status LED 12V/24V shows the battery voltage types, the status LED will be flashing in charging status in the day time and the light will be on solid in the night time. The "LVD" will be on solid in status "load off", if the voltage of the battery is too low. Table 1 gives lists of the status LED indications.

| Indicator light | Status | Indications | Loads | Remarks |
|---|---|---|---|---|
| ERR | On Solid | Battery Voltage Error | Off | Voltage Status Error |
| 12V | On Solid/Flashing | Stand-by/Charging | On | 12V Battery |
| 24V | On Solid/Flashing | Stand-by/Charging | On | 24V Battery |
| LVD | On solid | Low Voltage Protection | Off | Charging status only |

Table 1 Status LED definition

## 4.2 Maximum Power Point Tracking Technology

This controller utilizes maximum power point tracking technology (MPPT) to extract maximum power, Vmp, from the solar panel array. The tracking algorithm is fully automatic and does not require user adjustment. The MPPT technology will track the solar panel array maximum power point voltage, Vmp, as it varies with weather conditions, ensuring that maximum power is harvested from the solar panel array through the course of the day.

In most cases, the MPPT technology will "boost" the solar charge current. For example, a solar system may have 5A of solar current flowing into the unit and 7A to charge current flowing out to the battery.

This controller does not create current! Rest assured that the power into the unit is the same as the power out from the unit. Since power is the product of voltage and current (Volts x Amps=Power), the following is true.

（1）Power into the unit = Power out of unit

（2）Volts In x Amps In = Volts Out x Amps Out

*Assuming 100% efficiency. Losses in wiring and conversion exist.

If the solar panel array's Vmp is greater than the battery voltage, it follows that the battery current must be proportionally great than the solar input current so that input and output power are balanced. The great the difference between the maximum power voltage and battery voltage, the greater the current boost.

Another benefit to the MPPT technology is the ability to charge lower volt battery with solar panel array of higher normal voltages. For example, a 12V battery bank can be charged with 15-18-Vdc normal solar penal array. Certain grid-tie solar penal array may also be used as long as the solar penal array open circuit voltage, Voc, rating will not exceed the controller's 80Vdc maximum input rating at coldest panel temperature. The solar panel documentation should provide Voc vs. temperature data to users.

Higher solar input voltage results in lower solar input current for a given input power. High voltage solar input strings allow fro smaller gauge solar wiring. This is especially helpful for systems with long wiring runs between the solar panel array and the controller.

Traditional controllers connect the solar panel directly to the battery when recharging. This requires that the solar panel operate in a voltage range that is below the panel's Vmp. For example, in a 12V system, the battery voltage may range from 11-15Vdc but the panel's Vmp is around 17Vdc. Fig 7 shows a typical current vs. voltage output curve for a normal solar panel.

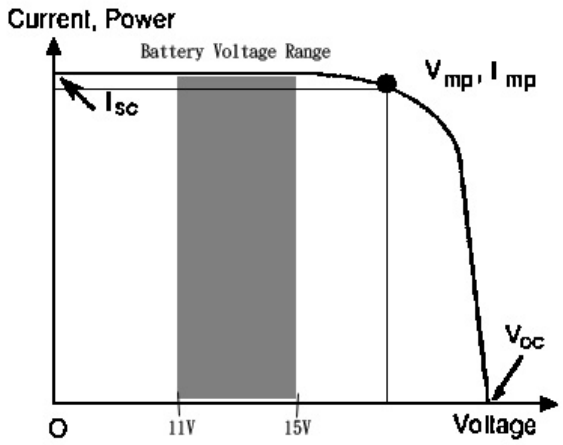



Fig. 7 Normal solar panel I-V curve

The panel Vmp is the max. power point, and before and after this point, the output power is reduced. (shown in Fig 7.)

Because traditional controllers do not operate at the Vmp of the solar panel, energy is wasted that could otherwise be used to charge the battery voltage and the Vmp of the panel, the more energy is wasted. The MPPT technology will always operate at the Vmp resulting in less wasted energy compared to traditional controllers, and transfer all the power from solar penal to loads or battery.

## 4.3 Information of Battery Charging

The MPPT unit has a 3 stages battery charging algorithm for rapid, efficient, and safe battery charging.

- (BULK CHARGE)
  In this stage, the battery voltage has not yet reached absorption voltage and 100% of available solar power is used to recharge the battery.

- (ABSORPTION)
  When the battery has recharged to the absorption voltage set point, constant-voltage regulation is used to prevent heating and excessive battery gassing.

- (FLOAT)
  After the battery is fully charged the unit reduces the battery voltage to a float charge which is sometimes call trickle charge.

## 4.4 Information of Load Control

The primary purpose of the load control function is to disconnect system loads when the battery has discharged to a low state of charge and reconnect system loads when the battery is sufficiently recharged.

CAUTION: Do not wire a AC inverter of any size to the load terminals of the controller. Wire inverters directly to the battery or battery bank.

## 4.5 Protections

Solar Overload
The unit will limit battery current to the 7A and 80Vdc maximum ratings. A over-sized solar panel array will not operate at peak power. The solar panel array (Volts x Amps) should be less than the unit's normal maximum input power rating for the optimal performance.

Load Overload(Status LED light "LVD" On Solid)
If the load current accessed the maximum load current rating, the unit will disconnect the load. The unit will attempt to reconnect the disconnect load automatically.

Night Time Solar Short Circuit
Solar input power wires of the controller has short-circuited to prevent the battery voltage re-flow back to the solar panel due to the solar panel voltage lower than battery voltage in the night time.

High Voltage Transients
In lightning prone areas, additional external suppression is recommended.

## 4.6 Inspection and Maintenance

Recommend at least two times per year for best controller performance.

- Tight all connectors. Inspect for loose, broken, or corroded connotations.
- Verify that all wire clamps and tie-downs are secure.
- Check and ensure the controller is mounted in a clean, ventilated environment, and no covering of the solar panel array.
- Verify LED indication is consistent with the present system conditions.

# 5. Troubleshooting

## 5.1 Error Indications

Status LED Error Indications

| | |
|---|---|
| · Battery Empty or System damage | All LED OFF |
| · Battery un-recognize, not 12V or 24V | ERR On Solid |
| · Battery voltage error | ERR On Solid |
| · Over power input | 12V/24V On Solid |
| · Load over current | LVD On Solid |
| · Battery low voltage (no error occur) | LVD On Solid |

## 5.2 Common Problems

Problems: No LED indications
Solutions: With a multi-meter, check the voltage at the battery terminals, the battery voltage must be at least 11V/22V to power the unit.

Problems: The unit is not charging the battery.
Solutions: If the status LED “ERR” is solid, see section 5.1 Error Indication. If the status LED is off measure the voltage across the solar input terminals of the controller. Input voltage must be greater than battery voltage. Check the fuses and solar wiring connections. Check the solar panel array for shading.

# 6. Detail Specifications

| PCM-924 | | |
|---|---|---|
| General Parameter | Unit | |
| Rated Input DC Power | W | 250(24V) / 125(12V) |
| Input Voltage Range | V | 36~80(24V)/18~80(12V) |
| Maximum Input Current | A | 7 |
| Maximum PV Voc | V | 80 |
| Maximum PV Isc | A | 10.5 |
| Battery (DC) voltage | V | 12 / 24 (Automatic) |
| Max Charge/Load Current | A | 9/7 |
| No.of Charge stage | | 3 |
| Self-consumption (in active status) | mA | 40 |
| Weight [kg] | | 0.68 |
| Dimensions [mm] | | |
| L (with connectors) | | 190 |
| W | | 125 |
| H | | 55 |
| Protection class | | IP67 Outdoor Use |
| Operating temperature | °C | -40~55 |
| Humidity (non-condensing) | | 0~100 |
| Cooling | | Natural Convection |
| Altitude | m | 0~2000 |
| MPPT Tracking | | V |
| Maximum Efficiency | % | 96 |
| Automatic load disconnect | | V (maximum load 7A) |
| Over load current protection | | V |
| Over charge protection | | V |
| Default settings | | |
| Absorption charge | | 14.4/28.8 V |
| Float charge | | 13.65/27.3 V |
| Low voltage load disconnect | | 11/22 V |
| Low voltage load reconnect | | 12.3/24.6 V |

# Appendix A – Wire Charts

## 12 Volt Nominal Wire Chart

| amps | One-way Wire Distance (feet) Wire Gauge (AWG) | | | | | One-way Wire Distance (meters) Wire Gauge ($mm^2$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 12 | 10 | 8 | 6 | 2.0 | 3.0 | 5.0 | 8.0 | 13.0 |
| 2 | 70 | 112 | 180 | 287 | 456 | 21 | 34 | 55 | 87 | 139 |
| 4 | 35 | 56 | 90 | 143 | 228 | 11 | 17 | 27 | 44 | 69 |
| 8 | 18 | 28 | 45 | 72 | 114 | 5 | 8 | 14 | 22 | 35 |
| 12 | 12 | 19 | 30 | 48 | 76 | 4 | 6 | 9 | 15 | 23 |
| 15 | 9 | 15 | 24 | 38 | 61 | 3 | 5 | 7 | 12 | 19 |

3% Voltage drop, Annealed copper wire at 20°C

## 24 Volt Nominal Wire Chart

| amps | One-way Wire Distance (feet) Wire Gauge (AWG) | | | | | One-way Wire Distance (meters) Wire Gauge ($mm^2$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 14 | 12 | 10 | 8 | 6 | 2.0 | 3.0 | 5.0 | 8.0 | 13.0 |
| 2 | 140 | 224 | 360 | 574 | 912 | 43 | 68 | 110 | 175 | 278 |
| 4 | 70 | 112 | 180 | 286 | 456 | 21 | 34 | 55 | 87 | 139 |
| 8 | 36 | 56 | 90 | 144 | 228 | 11 | 17 | 27 | 44 | 69 |
| 12 | 24 | 38 | 60 | 96 | 152 | 7 | 12 | 18.3 | 29 | 46 |
| 15 | 18 | 30 | 48 | 76 | 122 | 5 | 9 | 15 | 23 | 37 |

3% Voltage drop, Annealed copper wire at 20°C